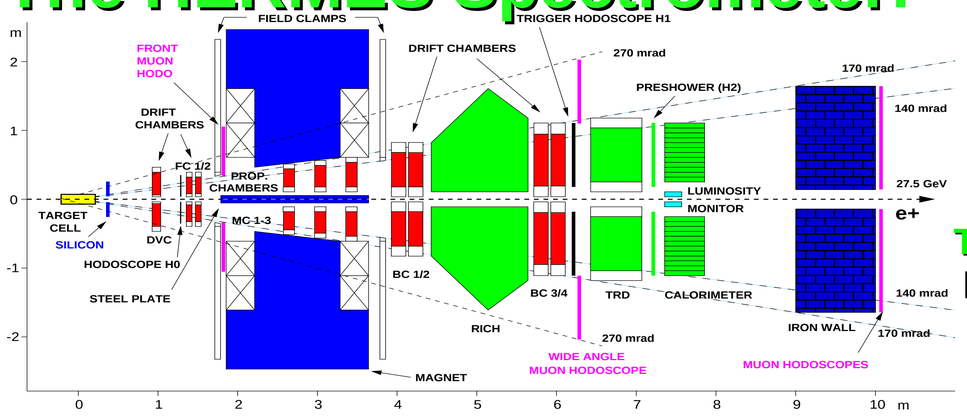
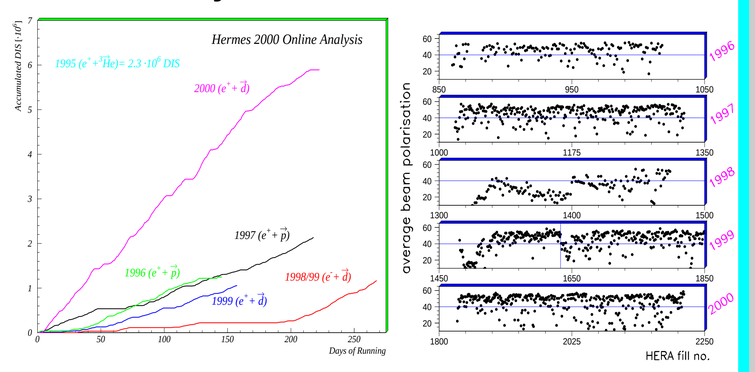
HERMES and the Spin of the Nucleon

The HERMES Spectrometer:



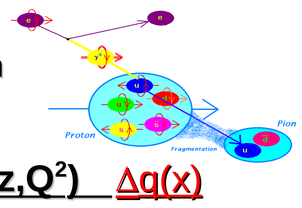
Internal Gas Target:
polarised Gases: H, D, He
unpolarised Gases:
H2, D2, He, N2, Ne, Kr
PID:
TRD + Calo + Preshower + RICH
lepton identification eff. > 98%
hadron contamination: < 1%

Luminosity and Polarisation 1995 – 2000



The Quark Polarisations Δq

Flavour Separation: Use correlation between struck quark and detected hadron



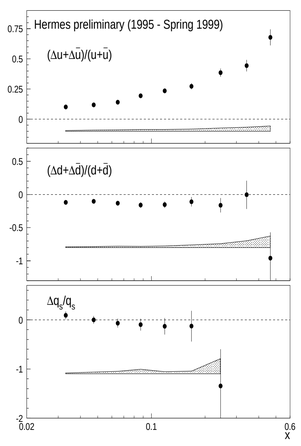
→ $\Delta u, \Delta \bar{u}, \Delta d, \Delta \bar{d}, \Delta s, \Delta \bar{s}$

$$A_1^h(x,Q^2) = C * \sum_f \frac{e_f^2 q_f(x,Q^2) \int dz\, D^h_f(z,Q^2)}{\sum_{f'} e^2_{f'}\, q_{f'}(x,Q^2) \int dz\, D^h_{f'}(z,Q^2)} \frac{\Delta q(x)}{q(x)}$$

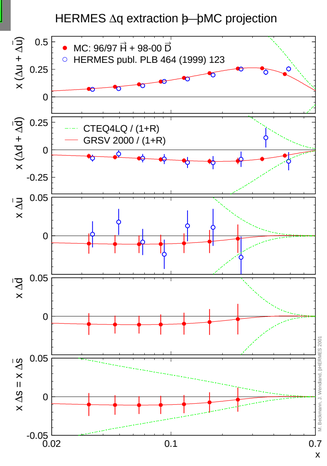
$$\rightarrow P_q^h(x,z)$$

To extract Quark Polarisations solve

$$\vec{\mathcal{A}} = \mathcal{P}\vec{Q}$$



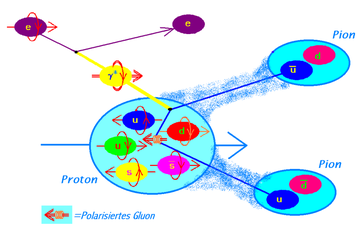
Quark polarisations extracted from the 1995−1999 data



MC − prediction for Polarised PDFs based on the measured data from1995−2000

The Gluon Polarisation ΔG

Direct Determination: Isolate **P**hoton−**G**luon **F**usion process

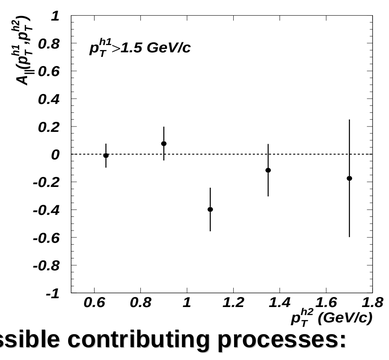


Select pairs of high p_T hadrons

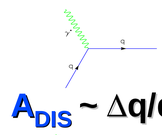
$$A_{\parallel} = \frac{N^{\Rightarrow\Leftarrow}_{h^\pm} - N^{\Rightarrow\Rightarrow}_{h^\pm}}{N^{\Rightarrow\Leftarrow}_{h^\pm} + N^{\Rightarrow\Rightarrow}_{h^\pm}} \sim -\frac{\Delta G}{G}$$

Estimated relative contributions using PYTHIA

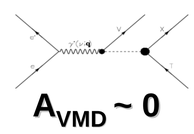
First negative asymmetry in DIS



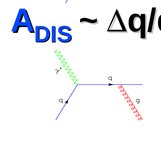
Possible contributing processes:



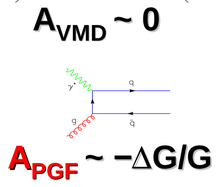
$A_{DIS} \sim \Delta q/q$



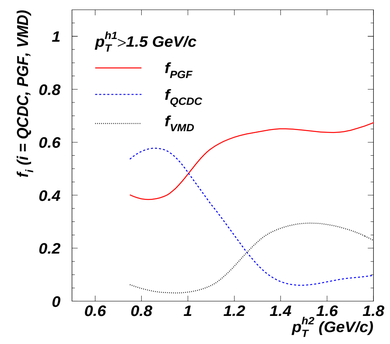
$A_{VMD} \sim 0$



$A_{QCDC} \sim \Delta q/q$



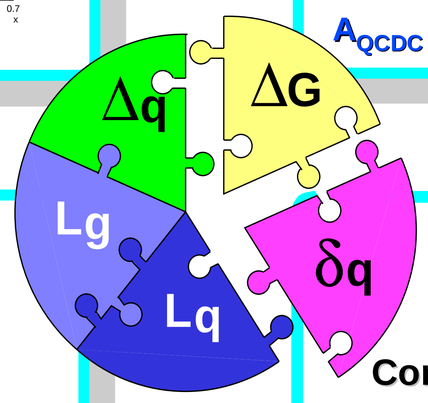
$A_{PGF} \sim -\Delta G/G$



ΔG/G is positive

ΔG/G = 0.41± 0.18 ± 0.03

Strong model dependence for ΔG/G extraction
Factor 2 smaller error bar with 1998 − 2000 data



Exclusive Reactions

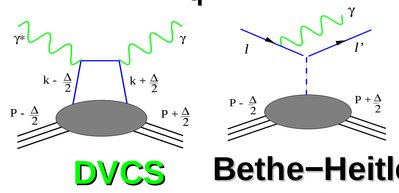
Analysis of hard exclusive processes leads to a new class of parton distributions

→ **Generalised Parton Distributions** $\mathcal{H}, \tilde{\mathcal{H}}, \mathcal{E}, \tilde{\mathcal{E}}$

Total quark angular momentum via second moments

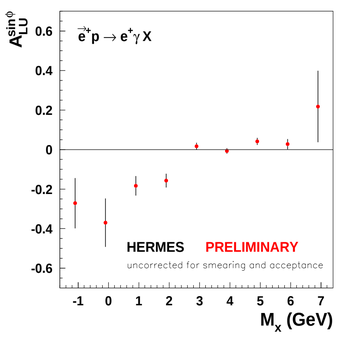
$$J^q = \tfrac{1}{2}\Delta\Sigma + L_q = \tfrac{1}{2}\int x\,dx\ (\mathcal{H}_q(x,\xi,t=0) + \mathcal{E}_q(x,\xi,t=0))$$

Simplest Process:
Deeply Virtual Compton Scattering
Isolate via BH−DVCS interference



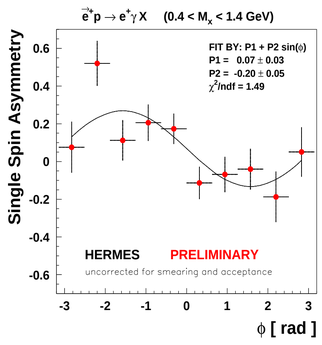
DVCS **Bethe−Heitler**

$$A_{LU} \sim \sin(\Phi_\gamma) \times \Im\left\{F_1 H_1 + \frac{x}{2-x}(F_1+F_2)\tilde{H}_1 - \frac{\Delta^2}{4M^2}F_2 E_1\right\}$$



Single Spin Asymmetry

Φ Dependence of SSA



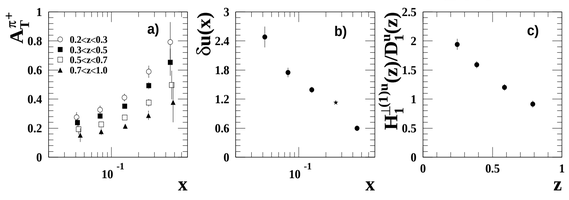
Measure 2004 – 2005 with new Recoil Detector to improve exclusivity of data

Transversity

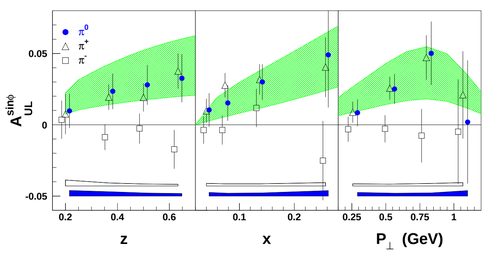
Completely unknown quantities $\delta q_f(x)$ and $H_1^\perp(z)$
can only be measured in semi−inclusive DIS
→ **chiral odd distribution functions $\delta q_f(x)$**
→ **chiral odd fragmentation function $H_1^\perp(z)$**

Prediction:
2001−2003 transversely polarised hydrogen target ⇒ 7.10⁶ DIS

$$A^{\pi^+}_p(x,y,z) = P_T\, D_{nn} \frac{\delta u(x)}{u(x)} \frac{H_1^\perp(z)}{D_1(z)}$$



What do we know already ?



Even with long. pol. H−target

$A_{UL}^{\sin\phi} \neq 0$

$A_{UL}^{\sin\phi} \sim S_T \Sigma_f e^2_f h_1^f(x) H_1^{\perp f}(z)$

S_T: transv. target spin component with respect to γ*

Spin dependent Collins fragmentation function $H_1^{\perp u}(z) > 0$

h_1 can be measured